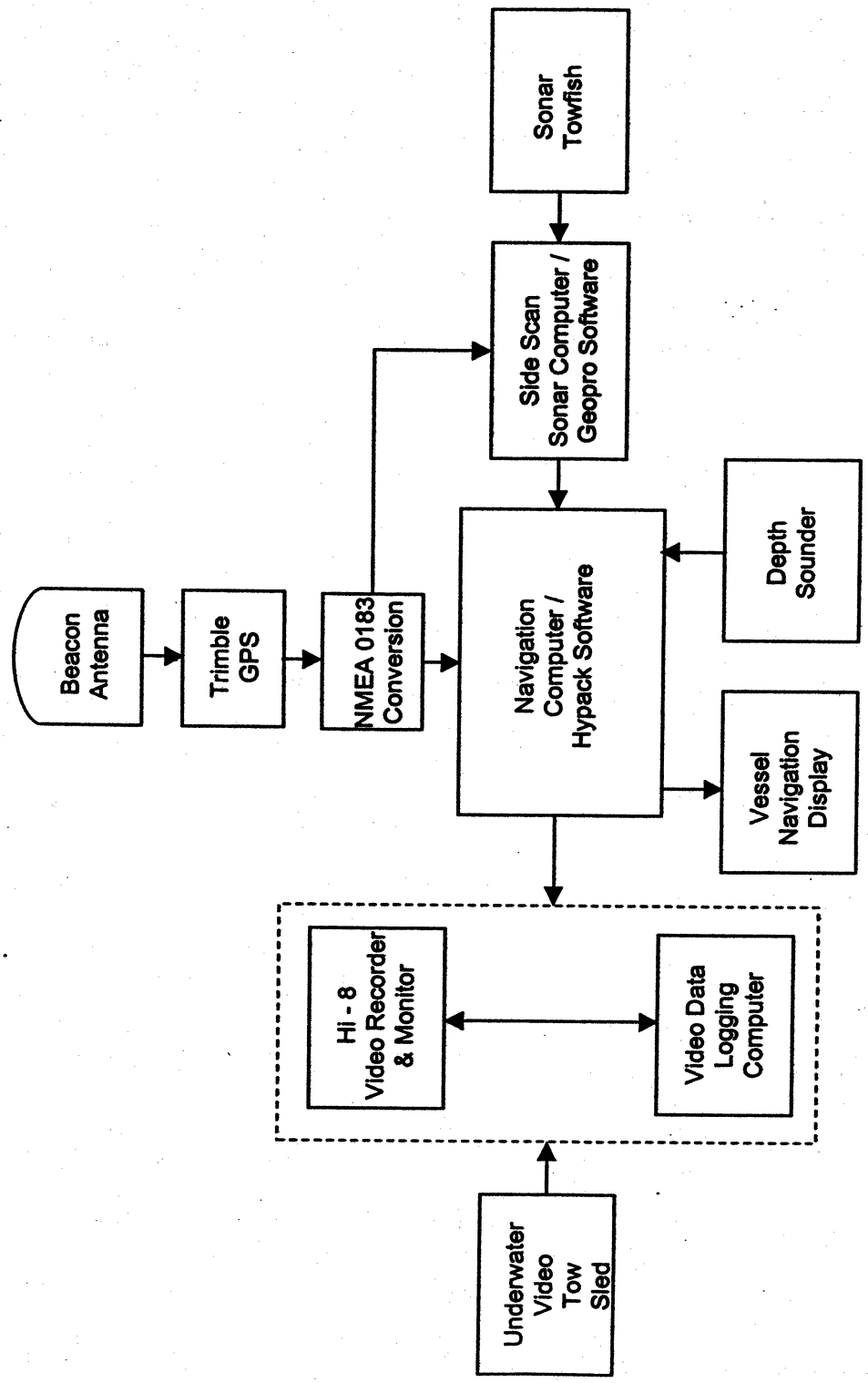

Figure 3. Instrumentation schematic on the *R/V Strait Science*

base templates. Survey track lines were entered in each area following the contour of the shoreline. An initial track line was entered at or just below MHW. Additional track lines were added parallel to the initial track line with an 85 m horizontal separation to a depth of -30 m. When integrated with GPS, this information provided the vessel operator real-time visual reference lines, vessel position, and port and starboard direction indicators for navigation along the survey line.

Position information was provided by a Trimble GPS Pathfinder Pro XRS system that included a 12-channel integrated GPS/Beacon/Satellite Differential receiver and recorded data to an accuracy of ±0.5 m. The GPS antenna was located amidship on the port side of the vessel. The survey software received NMEA0183 format latitude-longitude position information from the GPS and converted this to State Plane Coordinates (Washington State Zone North). The program merged position data with depth data every 1 second and data were recorded on the navigation computer and later post-processed to develop bathymetric records. The navigation computer/survey software also calculated position corrected for layback of the towed video camera based on length of cable out, corrected for catenary and the deck offset. The corrected position data was sent to the video data acquisition system. The side scan towfish offset and layback were entered directly into Geopro software.

2.1.2 Side Scan Sonar Data Collection

A GeoAcoustics LTD dual-frequency, side scan sonar system was used to collect real-time seafloor mosaic data with overlapping edges that were matched to form a continuous image of the bottom profile. The system consists of a tow fish, tow cable, transceiver, and a computer acquisition and control system. The main processing and

control system provides the acquisition target analysis and mosaic assembly features. The tow fish and tow cable contain the acoustic transducer array and associated preamplifier, digital electronics, and signal transmission lines.

Digital data from the side scan sonar system were collected along track lines with a separation spacing of 85 m. During the survey, both port and starboard sonar ranges were set at 60 m per channel (or side), which provided approximately 40% overlap of side scan images. One digital (or pixel) sample was taken for every 6 cm of the swath width perpendicular to the track line. Survey speed over ground was generally held at 3 knots or 1.5 m/second. However, this varied slightly depending upon currents and wind speed. Transducer firing rate was 200 ms at 60 m/side range. Assuming 1500 m/s one-way, sound velocity travel time, coverage parallel to track was approximately one pulse every 0.3 m. The theoretical maximum pixel size is 30 cm x 6 cm. The value is dependent on vessel speed and tow fish attitude (heading). Slight variations can occur due to changes in seawater sound velocity characteristics in the survey area such as variations in temperature and salinity gradients.

Side scan sonar data were recorded in two formats. The individual track line data were saved in Society of Exploration Geophysicists (SEGY) format and used for post processing and target analysis. Mosaic images were saved in GeoAcoustics proprietary format and later converted to tiff format for post-processing.

2.1.3 Underwater Video Data Collection

Underwater video footage was recorded along track lines perpendicular and parallel to shore. Sixty-two track line surveys covering the study area were conducted parallel to shore by Battelle, spaced 85 m apart out to a depth of -30 m. The track lines

were parallel to and 15 m shoreward of the side scan track lines. Video footage was recorded on Hi-8 mm tape with one to two track lines generally recorded on each hour of video tape. Seventy survey lines were conducted perpendicular to shore by MRC and recorded on VHS tape. Tracklines ranged in depth from +2 m MLLW to approximately -30 m. The specific transect locations for the perpendicular video were predetermined based on consultation with King County. Certain locations were selected to best represent the variety of habitat that might exist based on slope, proximity to creeks, geologic features, and upland features of interest. Several sites were chosen close to docks and piers that would otherwise be difficult to survey with parallel track lines. The remainder of sites were selected in areas E, G, and H.

The underwater video system that Battelle used consisted of a PNNL custom-built aluminum tow sled with a vertical stabilizer and bottom skids to protect the camera system. The camera used was a Super Circuits PC-33-C video camera with a Sony color charged coupled device (CCD) chip and 420 lines of resolution at 0.45 LUX. The lens was a 2.3mm wide angle with an 87-degree field of view. The camera was mounted in a pressure housing with a Plexiglas lens, in an "oblique-looking" orientation on the towsled. An artificial light source was not necessary and visible video footage was obtained down to -30 m. The video camera was towed approximately 1 m to 2 m off the bottom, depending on the type of habitat coverage and the vertical relief on the bottom. Tow speed was generally between 1.5 and 3 knots. This varied according to currents and surface winds, which influenced the speed and direction of travel to a certain extent. The visible video coverage on the bottom varied depending on turbidity in the water column

and the depth of the camera off the bottom. Generally, forward looking coverage varied from several meters up to approximately 10 m.

Video data was recorded on a Sony Hi-8 EVO-9500A video recorder and displayed on a Sony video monitor in real time during the survey. The depth of the camera in the water column was adjusted on board the vessel by the winch operator who monitored the video recording on screen. A date, time, and position (State Plane coordinates) stamp was digitally overlaid on the video signal and permanently recorded as part of the tape. This was updated every 1 second. The position information recorded was corrected for layback of the underwater tow vehicle relative to the vessel location. The date, time, and position signal were also recorded on the video data logging computer in an Excel spreadsheet for later post-processing of the video data.

MRC conducted 70 video tows (transects) between Picnic Point and Shilshole Marina that were perpendicular to shore from +1 m MLLW to a depth of -30 m MLLW. Underwater video images were obtained using a SeaCam 2000 underwater camera (DeepSea Power and Light, San Diego, California). The SeaCam uses a Hitachi VK-C150 CCD video camera equipped with a 4.8 mm Cosmicar auto-iris lens. The camera and lens were encapsulated in a Delrin plastic housing; a 250-W underwater light was provided. The camera was mounted in a "down-looking" orientation on a towfish deployed off the stern of the vessel. Deployment methods and data acquisition are described in Norris et al. (1997).

2.1.4 Bathymetric Data

This study was not intended to collect survey-grade bathymetric data. We did, however, record depth data during our side scan operations. An Inner Space

Technologies survey-quality depth recorder with a 5-degree, 100-kHz transducer pole was mounted amidships on the survey vessel *R/V Strait Science*. Depth data along with position information were recorded at 1-second intervals during side scan survey operations and post processed at a later date. A hardcopy of the bathymetry data was also recorded on an electrosensitive strip chart and digital data were collected in HYPACK.

Depth data were also recorded on the *R/V Brendan D II* as part of the video tows conducted perpendicular to shore. Depth was recorded at 2- to 3-second intervals using a 200-kHz or 50-kHz transducer. Depth data were corrected to MLLW manually at 10-minute intervals using predicted tidal heights for Edmonds and Meadow Point.

Depth data were processed in HYPACK for local time and tide difference. These data were then merged with the data collected aboard the *R/V Brendan D II*. Coordinate conversion from latitude/longitude to State Plane was performed in Tralaine software, a commercial conversion utility. After all corrections were incorporated, the data sets were merged in Microsoft Excel as X,Y, -Z format for analysis. A digital copy of the position and depth data for combined perpendicular and parallel track lines (corrected to MLLW) was provided to King County for further processing.

2.1.5 Diver Survey

Battelle conducted a SCUBA survey on November 17, 1999, to visually verify the substrate and habitat types previously observed on the videotapes and sonar imagery, and to assess the positional accuracy of the sonar records.

To verify the substrate and habitat type, two transects (shown in red, Figure 4) were surveyed at the southern end of Area E. This area was selected as representative of

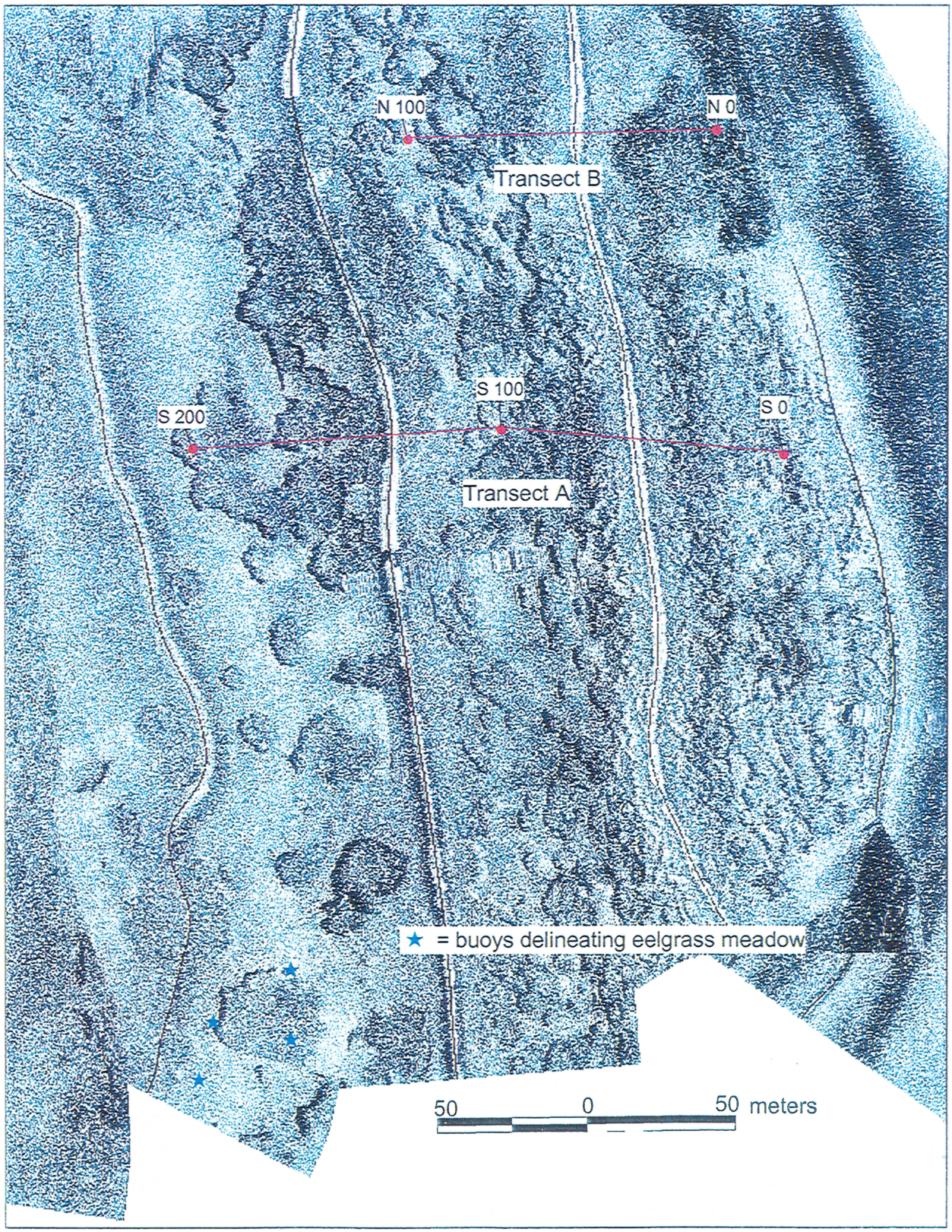

Figure 4. Diver assessment transects and buoy locations at the south end of Area E.